Knowledge uncertainties in environmental conflicts

How the mussel fishery controversy in the Dutch Wadden Sea became depoliticised

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Knowledge uncertainties in environmental conflicts: how the mussel fishery controversy in the Dutch Wadden Sea became depoliticised

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ABSTRACT

Policy-makers and scientists often expect that controversies in public policy can be solved by gathering more knowledge, even though this linear model of expertise is widely criticised in social studies of science. To shed more light on this expectation, the role of scientific uncertainties in controversies on mussel fishery in the Dutch Wadden Sea (1990–2016) is investigated. The analysis shows that mussel fishery regulation decisions were primarily based on government authority, not on scientific knowledge. Expectations of policy-makers and scientists on conflict resolution by more research were not met, because the knowledge debate was politicised over ambiguous knowledge claims. The controversy was depoliticised by a political covenant between the conflicting parties. The case study confirms that science-based knowledge fails to guide policy-making as expected in the linear model, and demonstrates how science plays important strategic, procedural and instrumental roles in structuring interactions between stakeholders in nature protection conflicts.

KEYWORDS Depoliticisation; knowledge expectations; knowledge uncertainties; science-policy interactions; mussel fishery; Wadden Sea

Introduction

Policy-makers and scientists often expect that scientific knowledge will conclusively solve conflicts in public debates. The underlying assumption is that, with the right knowledge, the appropriate decision should be clear. This linear model of expertise has become dominant among scientists, policy-makers and advisors (Pielke 2007, Beck 2011) in the field of protected nature areas (Beunen and Duineveld 2010, Turnhout *et al.* 2015, Floor *et al.* 2016). By analysing debates concerning the mussel fishery in the Dutch Wadden Sea (1990–2016), we critically assess the linear model. The mussel fishery case is an exemplary case of high expectations of scientific knowledge and simultaneously contested expertise. Several scholars have analysed the role of expertise and knowledge

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in the governance process of shellfish fisheries in the Wadden Sea region (Floor *et al.* 2013, Van Der Molen *et al.* 2015). Our research builds upon this work and focuses on the expected depoliticising role of knowledge from 1990 to 2016.

In analysing the roles of knowledge, we build on previous critical studies of knowledge use in environmental decision-making (Jasanoff 1994, Weingart 1999, Huitema and Turnhout 2009, Wesselink *et al.* 2013). The linear model assumes that science will provide policy actors with the knowledge required to resolve controversies (Beck 2011). The main criticism of this dominant model is its assumption of a clear boundary between science and policy (Beck 2011, Carter 2013, Wesselink *et al.* 2013), while science-policy interactions can better be understood as 'multiple, two-way and dynamic interactions between processes of knowledge production and decision-making' (Wesselink *et al.* 2013, p. 2). We analyse these dynamic interactions with the concepts of politicisation and depoliticisation. Politicisation refers to the confrontation of different positions about a human activity in the public debate (Mouffe 2000, Pellizzoni 2011); here, a shift occurs from a situation where a human activity was perceived as necessary, private and requiring no regulation towards a situation where human activity is a topic of public debate. For example, claims of interest groups and knowledge claims of science-based experts can trigger the politicisation process. Politicisation is 'the opening, broadening or restoring of a public space of discussion. An issue (or part of it) is politicised to the extent that it is released from necessity and duty: different positions can be confronted in the public arena' (Pellizzoni 2011, p. 711). Depoliticisation refers to the process of ending controversies, by removing these conflicting issues from the public debate and defining them as non-controversial, for example by placing them in the domain of scientific expertise (Behagel 2012).

In our analysis, we distinguish two interconnected and parallel debates: the regulation debate and the knowledge debate. The regulation debate in nature protection is about which human activities are allowable in a nature area and under what conditions. The knowledge debate is about what is known and whether there is sufficient knowledge to make decisions. We critically examine the 'linear' assumption that the knowledge debate needs to be closed to end the regulation debate (Beck 2011, Hoppe 2005). First, we present our conceptual framework of depoliticisation mechanisms and different types of uncertainties. Then, we use this framework to describe and analyse the mussel fishery controversy.

Analytical framework

Depoliticisation mechanisms

Several decision-making mechanisms can reduce the public debate on a controversial issue. We distinguish four depoliticisation mechanisms

Table 1. Decisionist, technocratic, participatory and market depoliticisation mechanisms (based on Van Koppen 2002).

	Depoliticisation mechanism
Decisionist	'Let the authority handle it', transfer to political hierarchy. The political position of the decision-maker justifies decisions.
Technocratic	'Let the experts handle it', transfer to the science-based expert domain. Scientific consensus justifies decisions.
Participatory	'Let the stakeholders decide', transfer to the semi-private stakeholder domain. An agreement between all relevant actors justifies decisions.
Market	'Leave it to the market', transfer to the private domain. The perception that market forces serve the common good justifies decisions.

based on Van Koppen (2002): decisionist, technocratic, participatory and market (see Table 1). We approach these decision-making mechanisms as ideal types. To function as a depoliticisation mechanism, the actors involved should accept the type of decision-making as legitimate, and the decision-maker(s) should be able to reach a decision.

These depoliticisation mechanisms are based on different types of legitimacy and knowledge use. The decisionist mechanism uses the legitimacy of the governmental authority (such as elected politicians or appointed officials) to make decisions. Knowledge as advice can play a supporting role in this process (Hoppe 2005). The technocratic mechanism relies on the legitimacy of experts and their scientific arguments to justify decisions (Weingart 1999). Knowledge is the main factor to guide decisions. In radical technocratic decision-making, scientists replace politicians; in a less radical version 'experts hold *de facto* power in the day-to-day business of administration and politics because scientific knowledge and its corresponding technical-practical tools have colonised the administrative and political worlds' (Hoppe 2005, p. 209). The participatory approach centres on the premise that affected actors should make decisions. It is crucial that all relevant stakeholders are included. Stakeholder and science-based knowledge can play a supportive role. The market mechanism centres on the ideology that market forces serve the common good, transferring the issue of decision-making to individuals collectively (Van Koppen 2002). Knowledge that informs market players can play a role, such as information on product labels.

In our analysis of the mussel fishery decision-making, we focus on the legitimation of decisions and the role of knowledge production in these decisions. We consider that knowledge has a role in all depoliticisation mechanisms but is most prominent in the technocratic approach.

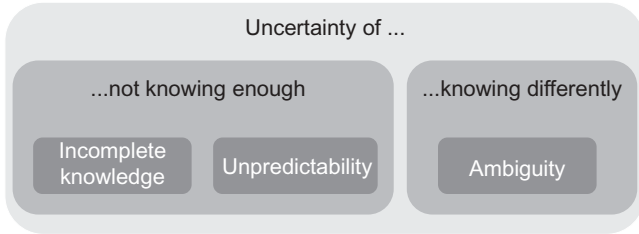

Figure 1. Schematic of types of uncertainties.
(*based on* Van Den Hoek 2014).

Knowledge uncertainties

In all depoliticisation mechanisms, the role of knowledge is complicated when knowledge uncertainties are considered. Knowledge uncertainties can fuel knowledge debates, and vice versa. As a result, knowledge claims can be undermined or become controversial. We analytically distinguish three types of perceptions of uncertainty: incomplete knowledge, unpredictability and ambiguity (Van Den Hoek 2014, Floor *et al.* 2016) – see Figure 1. The uncertainty of incomplete knowledge links to perceived imperfection of knowledge: things are currently unknown but potentially available through additional research. The uncertainty of unpredictability addresses unknowable knowledge: given the present state of science, science cannot reduce this uncertainty. The uncertainty of ambiguity concerns actors knowing differently rather than not knowing enough. Here, ambiguity is defined as 'the existence of two or more equally plausible interpretation possibilities' (Dewulf *et al.* 2005, p. 116).

Different types of uncertainties mark different knowledge debates. Perceptions of not knowing enough (incomplete knowledge or unpredictability) can trigger disputes about whether there is sufficient knowledge to support decision-making. Different ways of knowing (ambiguity) can trigger disputes around diverging knowledge claims. Ambiguity, however, is frequently not recognised and is often perceived as incomplete knowledge. The desire of coalitions to strengthen their position with better knowledge-based arguments implies high expectations for research. However, additional research will not change underlying value differences (Sarewitz 2004). We use our classification of uncertainties to understand knowledge debates and the extent that knowledge production can resolve them.

Linear model of expertise

We use depoliticisation mechanisms and knowledge uncertainties to characterise the linear model of expertise. The core assumption of the linear

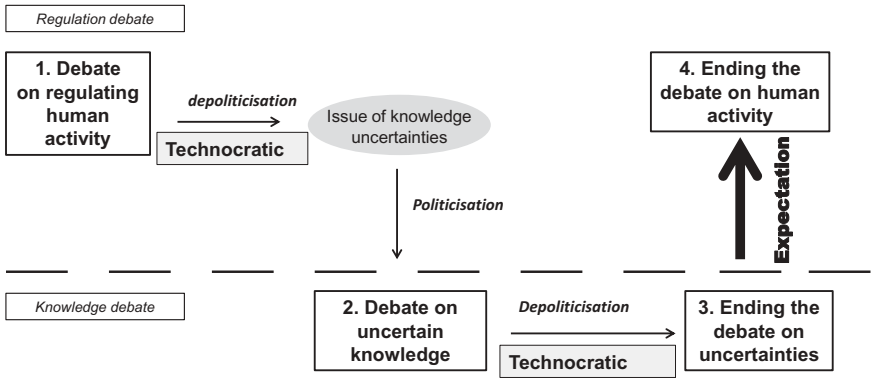

Figure 2. Visualisation of linear expectations of research for closing knowledge and regulation debates, based on the perceptions of technocratic depoliticisation and uncertainty as incomplete knowledge.

model correlates with the technocratic depoliticisation approach and uncertainty as incomplete knowledge, resulting in the following expectations of the regulation and knowledge debate. First, to depoliticise a human activity within a regulation debate, experts are required to provide the necessary knowledge for policy-making. This depoliticisation approach is complicated when uncertainties result in politicisation of knowledge. Based on the linear science-policy expectation, the issue requires additional technocratic depoliticisation to address the knowledge debate. Lastly, the linear model assumes that by ending the knowledge debate, it should become clear how to regulate human activity. In this way, ending the knowledge debate becomes a necessary condition for ending the regulation debate. Figure 2 summarises this linear expectation from research for decision-making. Our mussel fishery case study will show a different relation between the knowledge and regulation debates that challenges this linear expectation.

Methodological approach

We use an interpretative approach to understand the mussel fishery controversy (Yanow and Schwartz-Shea 2006). Interpretative approaches focus on different constructions of meaning as 'people will interpret the social and material world in various and sometimes conflicting ways' (Beunen and Duineveld 2010, p. 325). These differences between people form the basis of regulation and knowledge debates. Following Mouffe (2000), we view these debates as a result of conflicting positions between 'us' and 'them' that have different perspectives. We describe these different positions as discourse coalitions: 'a group of actors that, in the context of an identifiable set of practices, shares the usage of a particular set of story lines over a particular

period of time' (Hajer 2006, p. 70). We view these coalitions as having their own way of knowing (Janssen 2015). In the mussel fishery case, we identify nature and fishery discourse coalitions (Van der Molen *et al.* 2015).

In our analysis, we distinguish four periods in the mussel fishery case (1990–2016), based on crucial decisions that depoliticised the public debate and changed the regulation of mussel fisheries. We take 1990 as the starting point, when high bird mortality evoked the first politicisation of mussel fisheries. The analysis ends in 2016, when we concluded our data collection. Interviews, participatory observation, field trips and document analysis of the role of science-policy interactions in the Dutch Wadden Sea[1] empirically inform our case study. We conducted 28 semi-structured interviews on science-policy interactions in the Wadden Sea, 9 of which specifically focused on the mussel fishery case with persons from scientific institutes, nature organisations, the mussel fishery sector and the government. We analysed case-related research reports, governmental documents, stakeholder documents, court rulings, parliamentary proceedings, stakeholder websites, meeting notes and newspaper articles (using the Lexis Nexis database). For each period, we analysed the data on articulations of uncertainties and legitimations of decisions to identify depoliticisation mechanisms and knowledge expectations.

Mussel cultivation and fishery in the Dutch Wadden Sea

The Wadden Sea is a shallow estuarine sea, renowned as a feeding ground for birds. High tidal dynamics are characteristic: at low tide the littoral areas fall dry whereas sublittoral areas remain constantly covered by seawater. Another characteristic of the Wadden Sea is the occurrence of mussel beds, clusters of blue mussels (*Mytilus edulis*) that ecologists describe as biodiversity hotspots (Dankers and Zuidema 1995). There are naturally growing mussel banks and mussel cultivation plots. Mussel cultivation in the Wadden Sea started in the 1950s, with mussel farmers renting seabed areas from the national government. The mussel fishermen describe their cultivation practice as farming in the water (Van Der Molen *et al.* 2015). Cultivation starts with 'seeds', the spatfall of juvenile mussels, which form banks on the seabed by attaching themselves to old shelves and to each other. The main inputs for cultivation are juvenile sublittoral mussels, which are fished in autumn and spring and relocated to cultivation plots. Fishermen can also use littoral mussel banks to obtain juvenile and grown mussels. The cultivation plots are in the sublittoral area of the Wadden Sea. The mussels grow to consumption size in 2–3 years, after which fishermen bring them to the mussel auction in Yerseke in Zeeland for sale.

In the mussel fishery controversy, we identify two stable discourse coalitions based on a mussel fishery perspective and a nature conservation

perspective (Van Der Molen *et al.* 2015). The core story line of the fishery discourse coalition is *Mussel fishery belongs in the Wadden Sea*, articulating the historical and future place of mussel fisheries and cultivation in the Wadden Sea (Floor *et al.* 2016). The main actors in this coalition are the mussel farmers, represented by the Producers Organisation (PO) Mussel Culture. They emphasise the symbiotic relation between mussel fishing and nature protection: mussel cultivation as enriching nature. The ministry responsible for fishery and nature protection, the LNV Ministry,[2] has largely supported the mussel sector's position. Science-based experts are also part of the fishery discourse coalition (Turnhout *et al.* 2008, Van Der Molen *et al.* 2015). Historically, fishery biologists have taken the mussel fishery activity as a starting point, for example within research on improving fishing efficiency. During debates, nature organisations and fishermen placed some scientists explicitly in the fishery coalition; for example, researchers from the Netherlands Institute for Fisheries Research (RIVO, currently part of Wageningen Marine Science) (Turnhout *et al.* 2008).

The main story line of the nature discourse coalition is *The Wadden Sea is first and foremost a nature area*, articulating that human activities should not harm this unique area (Van Der Molen *et al.* 2015, Floor *et al.* 2016). The main actors have been the Wadden Sea Society, the Society for the Protection of Birds, Fauna Protection and the WAD Foundation. Although these nature protection organisations have different perspectives on the extent that fisheries should be in the nature area, they share concerns about bird populations and seabed disturbance. Their position is strongly rooted in ecosystem ecology and the interrelations of species, many nature organisations employees having science-based ecological expertise (Van Der Molen *et al.* 2015). Nature organisations and fishermen also placed within this discourse coalition science-based experts from research institutes, such as researchers from the Royal Netherlands Institute for Sea Research (NIOZ). The LNV Ministry also aligns with this discourse coalition, with increased recognition of the nature value of the Wadden Sea in international and national policy documents.

The mussel fishery controversy (1990–2016)

The politicisation and depoliticisation process and the role of knowledge occurred in four periods that distinguish different regulation of mussel fisheries. For an overview of the main events and a summary of the analysis, see Figure 3 and Table 2.

Main events and decisions			Research projects
No restriction of cockle and mussel fishery		1990	
	Almost all littoral mussel banks disappeared		
	High bird mortality in winter	1991	
		1992	
Crucial decision: Sea and Coastal Fisheries Policy (SCFP): 26% of the Wadden Sea restricted from fishery and 60% food reservation for birds		1993	
		1994	EVA I (1994-1998): evaluation of fishery regulation
		1995	
		1996	
		1997	
Adaptation SCFP: additional littoral areas closed		1998	
	High bird mortality in winter	1999	EVA II (1999-2003): evaluation of fishery regulations and fishery effect research
		2000	
Shellfish sector vision on sustainable fishery (ODUS)		2001	
		2002	
		2003	
European Court of Justice ruling: shellfish fishery as a project under the Habitat Directive		2004	
Government decision: ban on cockle fishery and permit for gas mining			
Crucial decision: Support sustainable mussel fishery, no more food reservations for birds instead autumn fishery restricted to instable mussel banks			
Workshops and meetings between fishermen and nature organisations until spring 2006		2005	
Council of State procedure against mussel seed fishery spring 2006 permit		2006	PRODUS project (2006-2013): fishery effect research on sublittoral nature values
Heldoorn informer start to bring nature organisations, fishermen and the Ministry together		2007	
Council of State ruling: spring 2006 permit invalid		2008	
Crucial decision: Transition covenant between nature organisations, fishermen and the Ministry			
Permanently closing 140 ha sublittoral mussel seed banks		2009	
Additional closing of 70 ha sublittoral mussel seed banks		2010	
		2011	
		2012	
		2013	
Additional closing of 9090 ha sublittoral mussel seed banks		2014	
		2015	
		2016	

Figure 3. Overview of important events, research projects and crucial decisions in the mussel fishery controversy (1990–2016).

Debate on restricting mussel fishery areas (1990–1993)

The high mortality of birds and disappearance of all littoral mussel banks triggered the politicisation of mussel fishery in the 1990s. In 1990, nature organisations supported by scientists attempted to limit the cockle fishery[3]. However, the Council of State (Raad van State) stopped governmental regulation because there was no legal basis for limiting shellfish fisheries.

Table 2. Overview of regulation and knowledge debates and depoliticisation mechanisms in mussel fishery decision-making (1990–2016).

Period	Regulation debate on mussel fishery regulation	Knowledge debate on uncertainties of effect claims	Depoliticisation mechanisms and role of knowledge uncertainties
1990–1993: Start politicisation of mussel fishery, focus on littoral mussel banks	Reduce fishery areas! versus No limitations of fishery areas!	Harmful fishery versus Natural fluctuations	• *Decisionist*: government decision to regulate fishery. • The policy included a compromise to address ambiguity on fishery effects for birds. • Knowledge as requirement for future decisions, initiating EVA I.
1993–2004: Technocratic debate on fishery effects	More regulation! versus Less regulation!	Potentially harmful fishery versus Positive effects of mussel cultivation	• *Decisionist*: government decision to support mussel fishery. • No scientific consensus on effects, ambiguity on interpretation of EVA II research results. • New research to address incomplete knowledge of sublittoral effects.
2004–2008: Restricted debate on permits, focus on sublittoral mussel banks. After Council of State verdict, increased public debate	Only mussel fishery without damage to the seabed versus Mussel fishery and cultivation is already sustainable	Too much incomplete knowledge to assess effects versus Sufficient knowledge to assess there are no significant effects	• *Legal decisionist*: nullification 2006 permit based on incomplete knowledge of sublittoral fishery effects. • Increased politicisation of the issue, reducing incomplete knowledge with research was unattainable. • *Participatory*: transition covenant enforced co-operation to end mussel fishery crisis in 2008.
2008–2016: Co-operation within mussel transition covenant	Pacified debate, redirected to semi-private sphere of covenant partners	Pacified knowledge debate, agreement to ignore ambiguity on fishery effects	• *Participatory*: co-operation in transition covenant. • Ambiguity in fishery effects is ignored by covenant partners. • Knowledge required to support covenant decisions.

This triggered a regulation debate between the nature and fishery coalitions, with *reduce fishery areas!* versus *no limitations of fishery areas!* as the conflicting positions. Nature organizations argued for closing areas to fisheries, particularly littoral areas, to leave enough food for birds. Fishermen emphasised that they had difficulties due to limited mussel spat and intensified eider duck predation on their cultivation plots. According to nature organisations, nature needed protection from fisheries, blaming fisheries for the disappearance of the littoral mussel banks and for eider duck mortality. Fishermen emphasised natural fluctuations of mussel banks and bird populations. These differences resulted in a knowledge debate: *harmful fishery* versus *natural fluctuations*. In 1993, the LNV Ministry formulated a compromise between the nature and fishery positions. Mussel fishery regulation became part of the Sea and Coastal Fisheries Policy: restricting 26% of the Wadden Sea area from shellfish fisheries, limiting fishing to leave sufficient cockles and mussels to satisfy 60% of the food requirement of the bird populations, and restricting fishing of littoral mussel banks if their surface coverage was below 2000 ha. Furthermore, the LNV Ministry planned a science-based evaluation to be ready in 1998, on which the fishery policy was to be adjusted to restrict additional areas or re-open them for fisheries (LNV 1993).

During this period (1990–1993), observations of bird mortality and contestation of fishery effects politicised mussel fisheries. Knowledge played an important role in this process of politicisation. In contrast to the linear model, scientific experts were unable to depoliticise the issue. While both the nature and fishery coalitions acknowledged the importance of knowledge, there was ambiguity about the effects of fishery, especially about the causes of high bird mortality and loss of the mussel banks. The Ministry acknowledged this uncertainty by formulating a compromise on fishing conditions to keep areas open for fisheries and simultaneously protecting nature. This decision, legitimised by the Ministry's authority, depoliticised the debate. With a research-based evaluation, the Ministry proposed a technocratic approach to guide further decision-making. All stakeholders perceived research as necessary to evaluate the effects of restricting areas for fisheries and to reduce the uncertainty about fishery effects.

Continuing debate on sufficient bird protection (1993–2004)

The Sea and Coastal Fisheries Policy of 1993 and the slow restoration of littoral mussel banks restricted the mussel fishery to sublittoral mussels. In 1998, evaluation research (EVA I) showed that the restoration of littoral mussel banks was very limited (Ens *et al.* 2004). Because there were insufficient data from which to draw strong conclusions on fishery effects, the LNV Ministry initiated a second evaluation project (EVA II). Although

this technocratic approach restricted debate to knowledge arguments, the regulation debate on shellfish fisheries continued. Nature organisations contested cockle and mussel fishery permits in court, claiming that fishery regulation was insufficient to protect nature as there was again high bird mortality in the winters of 1999–2001 (Raad van State 2005). Fishermen claimed that regulation hampered sustainable fishery innovations. In 2001, the shellfish sector published a sustainable fishery vision, which included an alternative method of juvenile mussel collection to innovate mussel fishery and cultivation. Mussel seed collectors with ropes in the water column on which juvenile mussels attached themselves should reduce seabed disturbance and create a more stable mussel seed input (ODUS 2001). However, in 2002, mussel fishermen also requested a permit to fish on natural littoral mussel banks. This was unacceptable for nature organisations, and the Ministry did not grant it (Raad van State 2004). We characterise this mussel fishery regulation debate as *more regulation!* versus *less regulation!*

Knowledge claims about fishery effects supported the positions of the nature and fishery coalitions. The main concern of the nature coalitions was bird protection. The removal of mussels would effectively reduce food availability for birds, especially in years with low numbers of juvenile mussels. In contrast, the fishery coalition claimed that the overall effect of mussel fishery and cultivation was positive for nature. The transportation of juvenile mussels to cultivation plots would increase the number of mussels because of the better survival conditions on cultivation plots, thus increasing the number of mussels available for birds. The coalitions had their own interpretations of the research results of EVA I and II, and science-based experts contested different interpretations of fishery effects. For example, model calculations in the EVA II project showed that cultivation increased the number of mussels in the Wadden Sea, which the fishery coalition perceived as confirmation of their position. The nature coalition, however, emphasised that, in years with low numbers of juvenile mussels, the actual effects for bird populations could still be negative. Furthermore, the nature coalition proposed changing the norm of food availability to restore bird numbers. We characterise this knowledge debate triggered by ambiguity about fishery effects as *potentially harmful fishery* versus *positive effects of mussel cultivation*.

Although the EVA II research project took place to guide decision-making on shellfish fisheries, other processes became more influential. First, the debate on gas extraction in the Wadden Sea influenced the fishery debate (Floor *et al.* 2013). In addition, the ruling of the European Court of Justice in 2004 that the European Habitat Directive permit procedures also applied to shellfish fisheries changed the legal setting (ECJ 2004). This decision implied that the burden of proof was on fishermen to show that there were no significant negative effects on the Wadden Sea's nature value

(Raad van State 2005). Against this background, in 2004, the Dutch government decided to support sustainable mussel fishery and support alternative mussel seed collection experiments, whereas the government banned mechanical cockle fishery from the Wadden Sea (LNV 2004).

In this period (1993–2004), knowledge did not contribute to depoliticising the controversy. Even though knowledge arguments structured the regulation debate, ambiguity about fishery effects amplified the knowledge debate. The high expectation that the EVA I and II evaluations could reduce the debate about fishery effects was not met. In contrast, science-based expertise became part of the debate about fishery effects as contested expertise. Again, the main uncertainty was the ambiguity about fishery effects. Fishermen also noted the unpredictability of the natural dynamics of the Wadden Sea: 'not everything can be described or explained' (ODUS 2001, p. 14). Still, fishermen were actively involved in the EVA II project, which structured the debate on mussel fisheries. For example, the debate on eider duck protection occurred with ecological arguments on food availability calculations. However, the ambiguity of the EVA II research results enhanced the debate instead of depoliticising it. Furthermore, the acknowledgement of incomplete knowledge of effects on sublittoral nature triggered new research: the PRODUS project ('PRoject Onderzoek DUurzame Schelpdiercultuur'), which aimed to support sustainable fishery and included research on the effects on sublittoral nature by comparing the biodiversity of fished and unfished plots. The Ministry expressed high expectations for this research: 'Knowledge and facts are seen as an opportunity to bridge the divide of standpoints and visions' (LNV 2004, p. 8). Again, the government proposed a technocratic approach for future decision-making. However, the crucial decision to support sustainable mussel fishery (and not cockle fishery) in 2004 was based on a decisionist approach, legitimised through the authority of the government. Although the Ministry legitimated this decision with its interpretation of the EVA II results and advised commissions, it was not technocratic in the sense of being prescribed by science-based experts.

Debate on mussel seed fishery permits (2004–2008)

In 2004, the LNV Ministry decided to support mussel fishery and cultivation in the Wadden Sea, whereas it banned mechanical cockle fishery (LNV 2004). As a result, the fishery on sublittoral mussel seed banks in spring and autumn could continue,[4] although fishermen now needed a permit under the European Habitat Directive (92/42/EEC). After a period of low spatfall and no fishing, the first fishing under this obligation was in autumn 2005. To determine eligibility for this permit, the Ministry of LNV commissioned research institute Alterra to write an appropriate assessment (Alterra 2005),

which concluded that there were no significant negative effects provided that only unstable mussel banks were fished. For the spring 2006 permit to fish mussel banks that survived the winter,[5] the PO Mussel Culture commissioned the consultancy MarinX, which assessed that there were no significant negative effects (Van Stralen and Sas 2006, Floor *et al.* 2016). In 2005 and 2006, several workshops and meetings, organised by the Ministry of LNV, took place between nature organisations, the PO Mussel Culture and science-based experts. Although they agreed that fishermen needed transition time to adopt new practices, they disagreed about the meaning of sustainable fishery and how quickly innovations should be realised. These differences between the fishery and nature coalitions' positions characterise the regulation debate: *mussel fishery and cultivation is already sustainable* versus *only mussel fishery without damage to the seabed*.

In March 2006, these differences led to discontinuation of regular meetings. Instead, nature organisations began legal proceedings against the Dutch government's granting a spring 2006 fishing permit, which redirected their differences towards a debate on the assessment of significant effects and the certainty of knowledge claims, triggered by the European Court of Justice condition of 'no reasonable scientific doubt' (ECJ 2004). We characterise this knowledge debate as *too much incomplete knowledge to assess effects* versus *sufficient knowledge to assess there are no significant effects*. The nature coalition questioned if the assessment of no significant effects was possible. Based on the precautionary principle, they claimed that there was insufficient knowledge to grant a permit. Incomplete knowledge of the effects of fisheries on sublittoral nature values implied that there could possibly be significant effects. In addition, they challenged the knowledge claims on mussel cultivation effects in bad years and food availability for birds, whereas the fishery coalition claimed that an assessment of 'no significant effects' was possible. Fishermen and the Ministry addressed the uncertainties about effects on sublittoral nature values with an adaptive management approach; if the PRODUS results showed negative effects, the fishery practice would be changed. Furthermore, they stressed the positive effect of an increase of mussel biomass by relocating mussels to cultivation plots. In 2007, in parallel with this legal conflict, the Ministry commissioned an independent facilitator to initiate meetings between nature organisations, the mussel sector and the Ministry.

In February 2008, the Council of State ruled that the spring 2006 permit was invalid, stating that there was inadequate understanding of effects to assess 'no significant effect' beyond reasonable scientific doubt (Raad van State 2008). This triggered a mussel crisis. Fishermen feared for their future, because without new permits it would be the end of the sector. Fishermen began the 'stop the green lie' media campaign against nature organisations and scientists who claimed mussel fishery was not sustainable. Initially, the

minister expected that the PRODUS research could be accelerated to provide the required scientific basis for new fishery permits. However, a scientific audit revealed that this was impossible. The ecological research needed much more time to draw valid conclusions about effects, and the auditors observed that the results would likely not reduce the controversy (Herman *et al.* 2008). In response, the Ministry intensified the search for co-operation, using an independent facilitator (Heldoorn 2008). In October 2008, this resulted in the Transition Mussel Sector and Nature Restoration Wadden Sea Covenant, signed by four nature organisations,[6] the PO Mussel Culture and the Ministry. This covenant implied step-by-step replacement of traditional mussel seed fishery with alternative mussel seed collection in 2020 and a nature restoration programme for the Wadden Sea.

In this period (2004–2008), knowledge production did not depoliticise the debate; instead, the legal decision on the knowledge debate about significant effect assessment even triggered intensification of the debate. The Council of State concluded in 2008 that there was insufficient understanding to assess 'no significant effects'. We view this as a legal decisionist mechanism to close the knowledge debate in which the court judged between different expert interpretations on whether there was sufficient knowledge to grant a permit. However, this decision triggered further politicisation of the regulation debate. After the Council of State's 2008 ruling, the public debate on the mussel sector increased, with intensive discussions in the media and the Dutch parliament. Relations between fishermen and nature organisations became very tense. It became clear that the technocratic mechanism based on the PRODUS research results would not provide a timely answer. Instead, the Ministry emphasised co-operation. This 'forced marriage' between nature organisations and fishermen in the transition covenant aimed to prevent further court cases on fishery permits and guarantee a transition process to innovative and more sustainable fishery practice. The involvement of the most relevant stakeholders, a participatory mechanism, legitimised the mussel transition covenant.

Co-operation within the mussel transition covenant (2008–2016)

The mussel transition covenant made it possible for fishermen to obtain a permit to fish in spring 2009, excepting the newly closed sublittoral areas. Fishermen also invested in mussel seed collectors, up-scaling the technical innovation to gradually increase the intake of juvenile mussels from the water column. Connected to the rise of this new technique, fishermen, nature organisations and the government agreed to permanently close additional areas to mussel seed fishery in 2010 and 2014 (PRW 2015). Science-based experts monitored the impact of mussel seed collectors and

natural development in the closed areas. In addition, the government supported research on the restoration of mussel banks.

The covenant depoliticised the debate on mussel fishery regulation by transferring the issue from the public domain of government to the semi-private domain of the covenant partners. Although differences between stakeholders did not disappear, the regulation debate became pacified. Nature organisations no longer opposed the permits in court. Moreover, interactions between the actors changed; instead of enforcing their own perspectives and using knowledge to enhance their positions, they had to shape the transition process together. For example, nature organisations and mussel fishermen had to work together to formulate a policy for juvenile mussel transportation. This is a controversial issue for nature organisations because of the invasive exotic species risk when transport takes place from the south of the Netherlands to the Wadden Sea (Van Der Molen *et al.* 2015). Through shared fact-finding, a workgroup of fishermen and nature organisations set up a monitoring programme, based on the input of science-based experts on species inventories.

The transition covenant pacified the knowledge debate on fishery effects. Co-operation between covenant partners depoliticised this dispute because the covenant partners decided that their contesting knowledge claims on fishery effects were not relevant for the co-operative process. This is very clear in the reaction to the PRODUS results in 2013; this research indicated both temporarily negative effects of mussel seed fishery in spring and high biodiversity of mussel cultivation plots (Smaal *et al.* 2013). After the signing of the covenant, interest in the PRODUS research declined. According to a researcher: 'the agenda of the covenant partners was dominated by other issues than what we could address with PRODUS'. Despite the government's and fishermen's initial high expectations of this research, the PRODUS results had no impact on fishery management; to avoid a new debate on knowledge uncertainties, the covenant partners decided to ignore the results. An interviewee from the mussel sector remarked: 'We did not discuss it properly, nobody was interested'. Nevertheless, the release of the PRODUS results in 2013 triggered scientific disagreement over the correct interpretation of the results. Scientists from the NIOZ research institute criticised the original press release for being too positive to mussel fishery, resulting in a new press release that emphasised the limitations of the research (IMARES 2013a, 2013b). However, stakeholders did not use or express this ambiguity to start a new mussel fishery regulation debate.

The mussel transition covenant pacified the debate on knowledge uncertainties of fishery effects in this period (2008–2016). Covenant partners used knowledge instrumentally to support decisions to implement the transition of mussel fishery practice based on an adaptive management approach of 'learning by doing'. There was no resolution of the knowledge debate on fishery effect uncertainties; however, the public debate on knowledge uncertainties of

fishery effects disappeared because the covenant depoliticised the regulation debate. Instead, covenant partners made shared decisions on mussel fishery management. To give legitimacy to their decisions as covenant partners, they continued to rely heavily on science-based expertise. 'Learning by doing' underpinned the transition, with monitoring and research projects to address incomplete knowledge and unpredictability. Furthermore, interactions between nature organisations, mussel fishermen and science-based experts changed. Instead of coalitions enforcing their own perspective and using knowledge to enhance their position, they began to work together to shape the transition process. However, this could be a temporary end to the controversy. First, excluded actors can question the legitimacy of the covenant. Some important outsiders to the covenant such as shrimpers and recreational organisations have criticised the covenant, though without repoliticising the issue. Second, the covenant partners themselves can withdraw from cooperation. The continuation of opposing views, the limited feasibility of a complete transition to mussel seed collectors and the formal end date of the covenant in 2020 threaten the current consensus. However, all actors still perceive collaboration as mutually beneficial.

Conclusions

No linear relation of knowledge and policy in the mussel case

This research is a response to persistent belief in the linear model of expertise. According to the linear model, the knowledge debate must first be resolved to end the regulation debate (see Figure 2). However, our mussel fishery case study showed a different relation between the two. The Dutch government initiated large research projects (EVA I, EVA II and PRODUS) with the expectation that their results would prescribe future decisions on mussel fishery. However, knowledge ambiguity hampered these technocratic expectations. Moreover, the legal ruling by the Council of State did not end the knowledge debate. The ruling that there was inadequate understanding of effects initially increased expectations that research should solve the controversy. However, research could not provide timely knowledge to address the incomplete knowledge of effects. Instead, mussel fishermen politicised the issue by accusing nature organisation and scientists of spreading the 'green lie'. Only the 2008 covenant between the conflicting parties pacified the controversy and effected a participatory approach. This pacification of the regulation debate circumvented knowledge controversies. Although the covenant partners still diverged in opinion, they set aside the knowledge ambiguity on fishery effects (see Figure 4), which made the knowledge debate on fishery effects irrelevant. We conclude that knowledge consensus was not a prerequisite for decision-making in this case. Instead, the decisionist and

participatory depoliticisation mechanism justified the decision for a mussel transition covenant. In contrast to the expectation that scientific clarity can put an end to policy controversy, we found that political closure of the regulation debate ended the knowledge debate.

High expectations of scientific knowledge explained

Although we criticise the linear model of expertise, this model is still essential to understand the high expectations of scientific knowledge to resolve controversies. Our distinction between a knowledge debate and a regulation debate, and the analytical concepts of knowledge uncertainty and depoliticisation mechanisms help explain these high expectations.

First, stakeholders in the debates perceived knowledge uncertainties predominantly as incomplete knowledge, even when our analysis shows that ambiguity about fishery effects was the main knowledge uncertainty in the decision-making process; instead of acknowledging this ambiguity, stakeholders initiated research projects with the expectation that the results would provide clarity about effects. The perception of uncertainty as incomplete knowledge was reinforced both by the technocratic conditions in the European Habitat Directive and the 2008 ruling of the Council of State. Thus, even when the research projects did not result in consensus among science-based experts, knowledge uncertainties were predominantly interpreted as incomplete knowledge.

Second, we observed a firm belief in the linear model of expertise among conflicting parties in the mussel fishery case. Both camps acknowledged scientific knowledge as a condition of legitimate arguments. Furthermore, there were high expectations that new research projects would support their coalition's position in the controversy. Only during the mussel crisis in 2008 did it become clear to stakeholders that they were mutually dependent upon each other and that strategic use of scientific arguments would no longer strengthen their position. This crisis resulted in sufficient political pressure to depoliticise the regulation debate through a participatory approach that resulted in the mussel transition covenant. This pacification of the regulation debate stopped the knowledge debate because the knowledge uncertainties on fishery effects addressed by different discourse coalitions became irrelevant to the policy-making process. Still, the belief in knowledge for decision-making processes continued in the 'learning by doing' approach.

Third, our analysis shows that expectations in line with the linear model can reinforce depoliticisation through technocratic mechanisms. For example, a proposed technocratic approach for further decisions enforced the legitimacy of the participatory mechanism. The legitimacy of the covenant was based on the participation of relevant stakeholders and on their

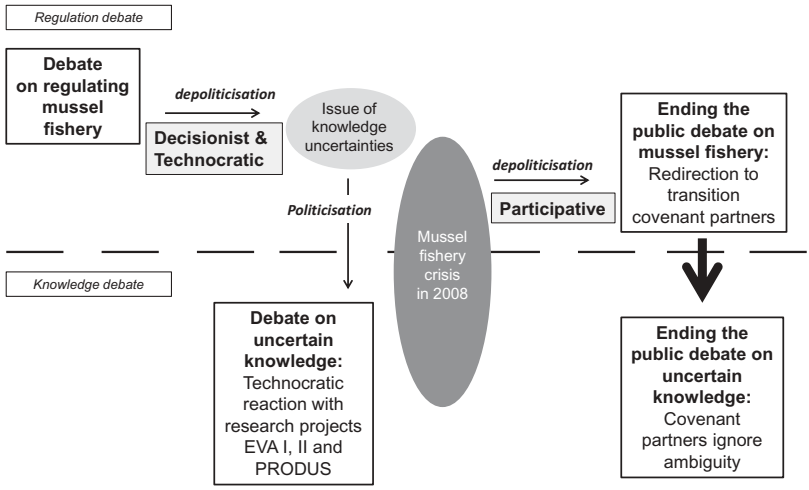

Figure 4. Visualisation of the depoliticisation of the regulation debate in 2008 with the transition covenant that triggered closure of the knowledge debate.

proposal to base their decisions on an adaptive management approach of 'learning by doing'. In a similar manner, research projects supported the legitimacy of the governmental decisions in 1993 and 2004. This shows that the technocratic mechanism played an important role in the legitimation of decisions by indicating that future decisions will be based on new information. Actors involved anticipated that new research results would resolve the knowledge debate, and consequently also soften the controversies in the regulation debate. Even though the actual research projects did not provide this clarity, expectations of future research persisted.

These findings have broader relevance. The three processes observed – a dominant perception of uncertainty as incomplete knowledge; the belief of actors that more knowledge will support their position; and the expectation that future policy decisions can be based on research results – will likely also occur in other nature conservation controversies. Simply criticizing the linear model of expertise will not have an impact on such controversies. Instead, we propose, there should be better acknowledgement of ambiguity and more reflection on the expected outcome of research projects. Indicating there is a social problem, and not just a technical problem, can redirect the controversy to the regulation debate where political choices are necessary.

The role of knowledge production in decision-making processes

This case study has shown that knowledge played an important role in decision-making processes, without resolving the controversy. Research projects played strategic, procedural and instrumental roles. All actors used research as a strategic tool. Nature organisations and mussel fishermen expected that additional knowledge would support their positions, resulting in research projects to find 'better' knowledge. Although additional knowledge could not reduce their ambiguity, research results increased the complexity of their scientific arguments. In addition, the Ministry used research in a strategic manner, by making scientists jointly responsible for permit decisions. Furthermore, research projects served a procedural role as an important meeting ground for discourse coalitions. Especially in the EVA II project, those with different perspectives had to work together. In the covenant, workgroups based on the 'learning by doing' approach facilitated interactions between different perspectives. Finally, stakeholders did not contest all knowledge produced, but used it instrumentally; for example, the raw data of mussel calculations and bird counts. These uncontested data formed the basis of co-operation within the covenant setting. To conclude, knowledge structured the decision-making process though it did not resolve the controversy. Knowledge and research can play crucial strategic, procedural and instrumental roles in decision-making processes, but resolving controversies that are characterised by knowledge ambiguity requires other depoliticisation processes.

Notes

1. We conducted data collection in January 2011–July 2016 as part of a PhD project on the role of science-policy interactions in the Wadden Sea. A full list of interviews is available on request. The authors translated quotes from the interviews into English.
2. The full name was Ministry of Agriculture, Nature and Fishery, and later Agriculture, Nature and Food Quality. In 2010–2017, it was part of the Ministry of Economic Affairs.
3. In this period, the fishery debate included cockle and mussel fisheries. This contribution focuses on the mussel fishery debate; for an overview of the cockle fishery debate, see Floor *et al.* (2013).
4. Regulation on bird protection changed in 2004. Instead of yearly food availability assessments, the government restricted fisheries to unstable mussel seed banks in autumn and introduced an administrative requirement to record mussel transports to keep 85% of the fished juvenile mussels in the Wadden Sea for the winter.
5. These mussel banks have the potential to become multi-year-old wild mussel banks; see Floor *et al.* (2016) and Alterra (2005) for details.
6. The following nature organisations signed the covenant ('Convenant Transitie Mosselsector en Natuurherstel Waddenzee'): the Society for the Protection of

Birds, the Wadden Sea Society, the WAD Foundation and the Society for the Preservation of Nature Monuments ('Natuurmonumenten').

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